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This invention relates to a visual display screen with integrated electro-acoustic function.

In television sets, the frontal surface of the cabinet offers few possibilities of installing loud speakers of sufficient quality for satisfactory electro-acoustic production. Nevertheless, considering the large volume of the cabinet that holds the cathode tube, load speakers with modest dimensions and quality, installed in this type of acoustic enclosure produce an acoustic reproduction that is suitable at least in regards to words. It will be noted that so long as the frontal surface of the television set is not considerably enlarged to omit the installation of high-grade loud speakers or the use of external loud speakers, spectator does not benefit from the acoustic quality that is potentially available in the audio signal. The deficiency in acoustic reproduction is particularly noticeable in the low register where for a given acoustic pressure, and a given membrane amplitude swing; the surface of the membrane of the loud speaker must be inversely proportional to the square of the frequency. Thus, loud

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[1]Numbers in the margin indicate pagination in the foreign text.

speaker with a diameter of 10 cm providing suitable reproduction and 150 Hz should have a diameter that would be increased to 13 cm, with the same swing, to reproduce the frequency of 50 Hz at the same level. Except in a very special case, a loud speaker with a diameter of 30 cm is never installed in a television set.

The problem thus is to find a large frontal surface that would be available in a television set. The propose solution involves using the surface of the screen itself.

This is why the invention relates to a visual display screen with integrated electro-acoustic function characterized in that it comprises control means (4, 44, 47, 49) that enable it to impart vibrations at acoustic frequencies suspension means 48 making it possible to link the screen to a fixed support.

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Various objects and features of the invention will appear more clearly in the following description, by ways of example and referring to the attached figures.

Figures 1 and 2 show an exemplary embodiment of the invention, applied to television stations.

Figure 3 shows an exemplary embodiment of the motor for the control device in Figures 1 and 2.

Figure 4 and 5 show another exemplary embodiment applied to a television station.

Figure 6 shows an exemplary embodiment of the invention applied to a retro-projector.

Figures 7 and 8 show an exemplary embodiment of the invention applied to a system for projection on screen.

Figure 9 shows an exemplary embodiment of an inertial control motor.

Figures 10, 11, and 12 show exemplary embodiments of the invention applied to a flat screen of the liquid crystal screen type, of the plasma type or with electro-luminescent diodes.

The direct view cathode television sets today are the most wide screen models. Considering the mass, its attachment to the cabinet and its sensitivity to vibration, the cathode tube cannot have its screen operated by a loud screen motor. According to the invention, before the screen of the cathode 14
tube, one provides transparent panel or a slightly absorbent panel (10 to 30% absorption for example to improve the contrast) operated by one or several motors of loud speakers placed along its periphery.

Practical, non-restrictive examples are given.

Figures 1 and 2 show an exemplary embodiment of a television station. The front view of Figure 1 shows a general view of the television station with a screen 2 connected to the cabinet 1 of the station by a flexible joint 5.

Cathode 2 ray 3 is visible through screen 2. Electro-magnets 4, 4.1, 4.2, 4.3 make it possible to use screen 2 as the membrane of the loud speaker.

Figure 2 shows a profile of the television set in Figure 1; here we see screen 2 situated in front of the cathode ray 3 and controlled by at least one electro-magnet 4 (or motor). A shielding 6 surrounds the cathode ray 2, 3 to isolate the magnetic effects of the motors (electro-magnets), such as 4.

Figure 3 shows a motor such as motors 4 or 4.1, 4.2, 4.3 in Figures 1 or 2.

The motors considered are those of conventional electro-dynamic loud speakers. A radial magnetic field is created perpendicular to the surface of a mobile cylindrical coil, subjected to currents in gendered by the audio signal [and] this coil is integral with the transparent screen and is attached at a point on its peripheral. The four edges of the screen are made integral with the cabinet by a flexible joint of the polymer tissue type (synthetic caoutchouc) embossed or rolled featuring a technology similar to that of the external suspensions of electro-dynamic loud speakers.

Screen 2 is preferably made of transparent polymer of the PMMA or TPX type, or even lighter and presenting at once, superior mechanical losses and rigidity.

To symmetrize the constraint applied to the transparent screen several loud speaker motors can be used along its periphery; in all cases, the audio frequencies (acoustic frequencies) reproduce by that screen will not exceed several hundreds of hertz. The higher frequencies are reproduced by one or several loud speakers with small dimensions.

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Figure 4 shows an exemplary embodiment where screen 2 has edges or prolongations 20, 21 that are folded away at an angle of 90° with respect to the surface of the screen. On these prolongations 20, 21 are made conductors 49, 49' that surround the screen. The prolongations 20, 21 are situated between magnets 44, 44'.

The motors considered are derived from those of ribbon loud speakers. The conductor or the conductors 49, 49' subjected to audio current, are arranged directly by evaporation, by an electro-chemical process or some other process, on the transparent screen, and along its periphery.

Thus the conductors are subjected to a magnetic field, so that a current circulating in these conductors causes a displacement of screen 2 perpendicularly to its plane. The motor has a length of less or equal to the length of the side of the screen that it moves. Four motors of that type (1 per side of screen) for example can be used to operate the four edges of

the screen; in that case the conductors can be continuous, from one motor to the next. One then gets a set-up as shown in Figure 5.

The loud speaker motor is used will have little magnetic leaks and/or the cathode tube shall be magnetically yielded.

Referring now to Figures 6 to 8, we can now describe an exemplary embodiment of the invention applied to image projection television sets.

In this type of television set, it is really the visual display screen, where the projection is done which constitutes the diaphragm of the loud speaker and not a transparent screen, placed in front of the fixed cathode screen of the direct vision tube.

Figure 6 shows the application of the invention to a retro-projection apparatus.

The source of tri-chrome images 7 is usually made up of three cathode tubes that is red, green, blue or three tubes with liquid crystals equipped respectively with red, green, blue filters and illuminated by one and the same light source.

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All image projection modes are included in the device shown in Figure 6 (scanning and modulation of laser beams etc). Compact structures of retro-projectors are obtained by folding back the

light beams with the help of one or several mirrors 8, 8' (see Figure 6).

The visual display screen 2 receives the light beams from the back and diffuses them forward in a limited angular field (directive screen or gain screen).

This screen is made up of one or two transparent cast polymer sheets and on its front, generally has a network of vertical, semi-cylindrical lens and in the back a Fresnel lens.

According to the invention, the techniques used to make this screen work as an electro-acoustic diaphragm are the same as those used earlier. Screen 2 is controlled by motors 4, 4' that are controlled by a radio signal. Screen 2 then acts a loud speaker membrane.

We note that the swings of the screen perpendicularly to its plane are weak (0.1 to 0.5 mm) as compared to the focus distance (1 meter or more); the vibrations of the screen thus do not bring about any visible effects on the image moreover, the constraints on the magnetic leaks on the loud speaker motors and/or the shielding of the cathode tube are greatly diminished in the case of the retro-projector due to the distance between the motors and the tubes.

Finally, it is a good idea to treat the cabinet of the retro-projector as an acoustic enclosure: absorbent on the inside faces rigidification of the walls enclosure tuning either

in the closed mode or in the low reflects mode, with vents (decompression orifice 10).

Figure 7 and 8 show a television set with front projection.

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In this case, the television projector 7 and screen 2 are separated. They are arranged as are the screen and the projector of slides or motion pictures. The device involved in the invention can be applied only if screen 2 has certain rigidity cr is mounted on a frame; it is not possible as a matter fact to get a coating tissue screen, suspended by the upper edge to act as loud speaker diaphragm.

The frontal projection screens are often rigid and display concave shapes that cannot be developed (portions of paraboloids). Such shapes give these screen properties of directivity necessary so that the luminance would attain a sufficient level in the angular field of vision. These screens can be operated as loud speaker diaphragm according to the following techniques. We note that contrary to the early cases the screen is a reflector; the loud screen motor or motors can be arranged behind the screen at not necessary along its periphery, as earlier.

When the rigid screen is attached on its frame as shown in Figure 7, the length between the screen and the frame is made with the help of flexible joints 11, 12, 13, 14 necessary for

the sweep of the screen working as loud speaker diaphragm. The mobile coil of a loud speaker 4 made of conventional technology is made integral with the screen, for example in its center; the armature of that motor is attached to the support frame. Other configurations are possible in particular those where all the connection of the screen are made by loud speaker motors. In figure 6, all of the flexible joints 11 to 14 are replaced by loud speaker motor, working in phase and where the central motor can be eliminated.

It will be noted that such a loud speaker works like a non-baffled membrane with a large surface and that this involves one of the preferred configurations for electro-acoustic reproduction with a very high range (including electro-static and electro-magnetic loud speakers with wide ribbons).

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When the rigid screen is suspended on the wall as shown in Figure 8, by its upper edge with the help of a suspension 10, it is the contact points of the screen with wall 9 that bear the flexible joint and/or the loud speaker motor 4.

The invention also makes it possible to use inertial motors as shown in Figure 9.

The inertial motors can be attached directly on the rear of the screen 2 without any support points. They work on the basis of the "action of mobile units 50, 51 reaction of support

screen" principle by virtue of the equality of movement quantities: [Please insert formula, page 7, line 14] where m is the mass of the mobile unit (activated by the audio current) and v is its speed. M is the mass of the screen and V is its speed. These motors are very effective at frequencies that are lowered by some hundredths of Hz where they excite the resonance modes of the shell or the plate of the screen; the latter are amortized by the usual techniques (inertial masses based at the vibration centers, joints with the screen support made of flexible and absorbent materials, etc).

Finally, the invention is also applicable to flat screens so that the latter will work by way of light emission (trans-illuminated liquid crystals, plasma, electro-luminescense etc) or by way of reflection (reflected liquid crystals, electro-chromes etc).

Figure 10 showed a device comprising a transparent screen 2, driven by peripheral out speaker motors as in Figure 1, and placed in front of flat screen 30.

Figure 11 shows a device where flat screen 30 can be driven by one or more loud speakers motors 4 that are integral with frame 32 or supported on a wall and connected to that frame by flexible joint 31.

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Figure 12 shows a device where flat screen 30 is driven by one or several inertial motors 4 which are integral with it.

It is quite evident that the proceeding prescription was given only by non-restrictive example and that other variants can be contemplated going beyond the frame work of the invention.

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CLAIMS

1. Visual display screen with integrated electro-acoustic function characterized in that it comprises control means (4, 44, 47, 49) enabling it to impart vibration at acoustic frequencies, suspension means 48 making it possible to connect the screen to a fixed support.

2. Screen according to claim 1 characterized in that it comprises of at least one electro-magnet that receives an electrical signal at acoustic frequencies and has a mobile armature and is integral with the screen.

3. Screen according to claim 1 characterized in that it is made of transparent or quasi-transparent material and that it is placed in front of the cathode ray tube of a television, the control means being placed along the periphery of the screen.

4. Screen according to claim 3 characterized in that it comprises of magnetic shielding means (6) surrounding the

cathode ray tube, and insulating the latter against the electro-magnets.

5. Screen according to claim 2 characterized in that it comprises of at least one permanent fixed magnet (44) and that the mobile armature bears a coil through which one can run a control current at acoustic frequencies.

6. Screen according to claim 5 characterized in that the mobile armature is a prolongation (20, 21) of screen 2 that is essentially folded back at 90° with respect to plane of the screen and that this prolongation (20, 21) bears electrical wires constituting a coil through which one can run an electric current at acoustic frequency.

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7. Screen according to claim 6 characterized in that the four edges of the screen (2) are folded back at 90° and that the folded prolongations are situated between magnets.

8. Screen according to claim 1 characterized in that the screen is a projection screen connected to a support by one or several electro-acoustic transducers.

9. Screen according to claim 1 characterized in that the screen is a flat visual display screen of the type with liquid crystals, with plasma, or with electro-luminescent diodes.

10. Screen according to claim 1 characterized in that the screen is the screen of a retro-projector, comprising control

means that make it possible to impart to the screen vibrations at acoustic frequency while the enclose of the retro-projector constitutes the tuned acoustic cavity, connected to the screen, which thus constitutes the acoustic membrane of a loud speaker.

11. Screen according to claim 1 characterized in that the control means are inertial motors that are integral with the screen, the screen being a projection screen or a retro-projection screen or a flat visual display screen.

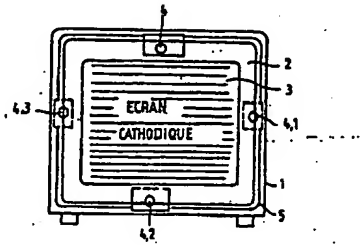


FIG.1

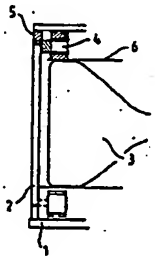


FIG.2

Figure 1

KEY:

ECRAN CATHODIQUE - CATHODE SCREEN

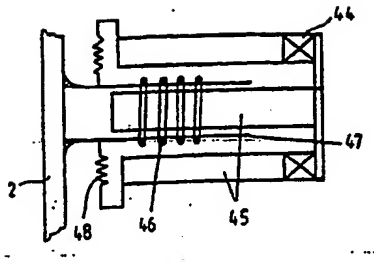


FIG.3

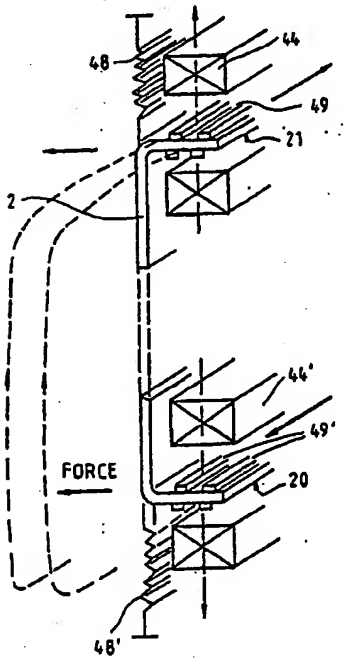


FIG.4

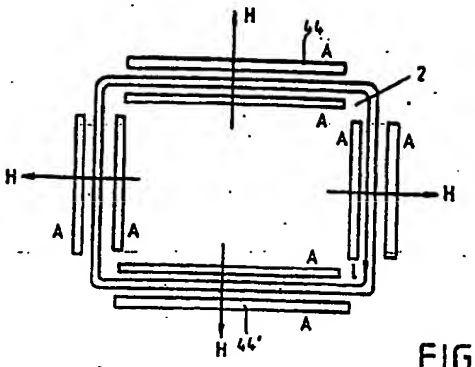


FIG.5

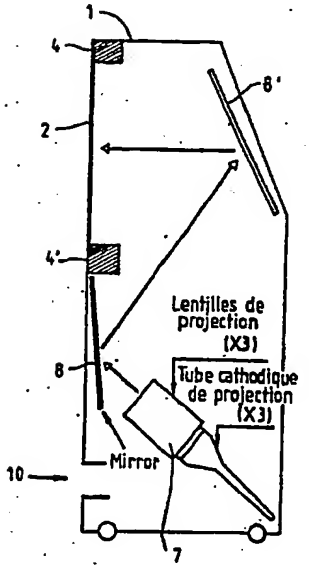


FIG.6

Figure 6

KEY:

Lentilles de projection - projection lenses

Tube cathodique de projection - cathode projection tube

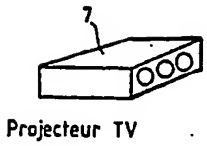
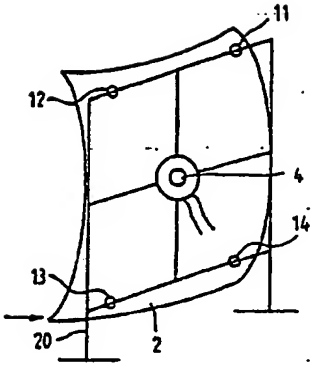


FIG.7



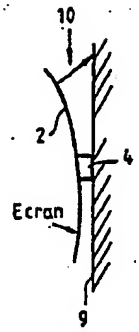


FIG.8

Figure 7

KEY:

Projecteur TV - TV projector

Figure 8

KEY:

Ecran - screen

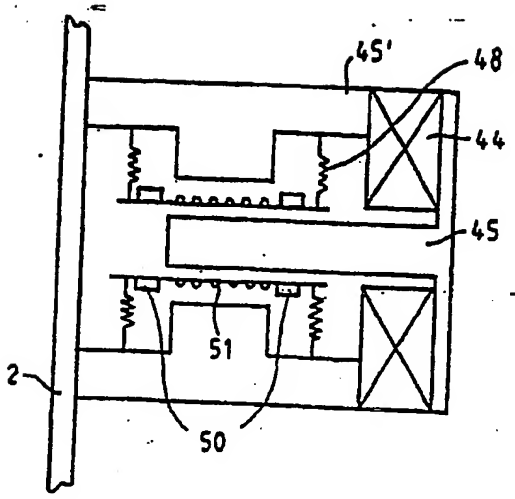


FIG.9

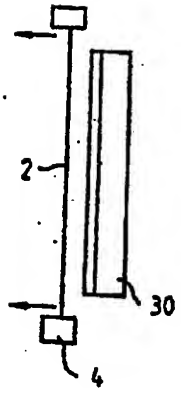


FIG.10

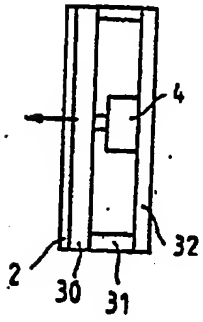


FIG.11

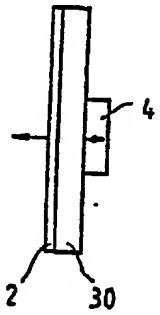


FIG.12